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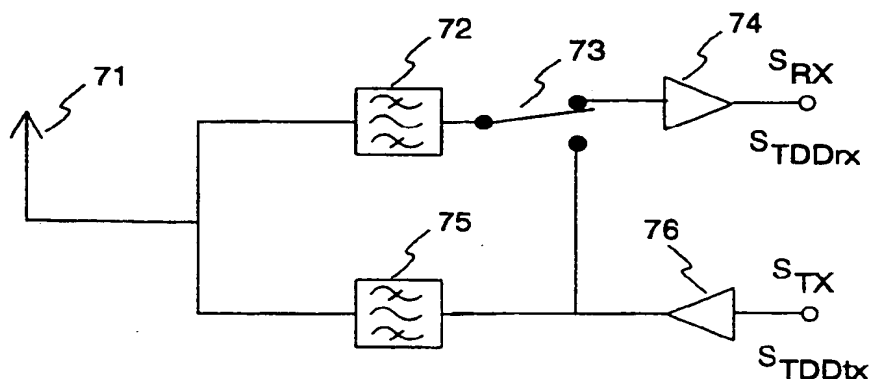
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(54) **Arrangement for transmitting and receiving radio frequency signal at two frequency bands**

(57) The present invention relates to an arrangement for transmitting a radiofrequency signal at two different frequency bands and for receiving at two different frequency bands. The arrangement can be applied for instance to a transceiver of a radio communications system operating at two different frequency bands, or to a transceiver meant to be used in connection with two different radio communications systems. One of the ideas

of the invention is that one and the same filter (72), belonging to the RF front end of the antenna circuit, is used for filtering interference from at least two signals located at different frequency bands, in which case the number of filters (72, 75) can be reduced. By means of the solution suggested in the invention, also the number of controllable switches (73) provided on the signal path of the RF front end can be minimised.



**FIG. 7**

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## Description

The present invention relates to an arrangement for transmitting radio frequency signal, i.e. RF signal, at two different transmitting frequency bands and for receiving at two different reception frequency bands. The arrangement is applicable, among others, in a transceiver of a radio communications system operating at two frequency bands or in a transceiver meant to be used in connection with two radio communications systems.

Mobile communications systems develop and grow rapidly, wherefore in many areas, there have been built or are being built systems according to several different standards. Consequently a need has arisen for such mobile stations that can be used in more than one system. Moreover, there are being developed new, so-called third-generation systems that will probably require dual mode operation of the receiver. Among these systems, let us point out the UMTS (Universal Mobile Telecommunications System) defined by the ETSI (European Telecommunications Standards Institute) and the FPLMTS (Future Public Land Mobile Telecommunications Systems) defined by the Radio Sector of the International Telecommunication Union.

Figure 1 is a block diagram of the radio frequency parts, i.e. RF parts, of a prior art multi-mode mobile telephone operating at two different frequency bands. This type of arrangement is described in the patent application [1] EP 678,974 A2. The system includes a separate RF front end for both frequency bands as well as for the receiver and the transmitter respectively; in the receiver part, this RF front end comprises a pre-amplifier 2, 27 and an RF filter 3, 28, and in the transmitter part filters 19, 23 and a power amplifier 18, 24 as well as duplex filters 1, 25 for both frequency bands.

In order to be able to use the respective RF parts at each frequency band, two-way switches 26, 29, 31 are provided in the antenna front end and at the antenna-side ports of the mixers of the receiver and transmitter. While operating at two different frequency bands, two duplex filters 1, 25, two preamplifiers 2, 27 and two RF filters 3, 28 are employed in the signal reception. Respectively, in signal transmission, there are used two RF filters 19, 23 of the transmitter, two power amplifiers 18, 24 and two duplex filters 1, 25. By means of the two-way switches 26, 29, 31, one of the two blocks of the same type are always in use. In order to create two different first mixer frequencies LO1, in the synthesiser S1 there are provided two voltage controlled means of the two-way switches 26, 29, 31, one of the two blocks of the same type are always in use. In order to create two different first mixer frequencies LO1, in the synthesiser S1 there are provided two voltage controlled oscillators 13, 30, one of which is switched to be active by the controls V1 and V2, depending on the respective frequency band of operation, for instance the frequency band of the GSM or the PCN system. The employed controls V1 and V2 can be the oscillator operating voltages (i.e. one is switched to operating voltage, the other is not). Each oscillator 13, 30 gives a different output frequency. Instead of different oscillators, in the formation of different mixer frequencies LO1 it could be possible to use two different frequency synthesizers S1, one of which is always selected to use, depending on the frequency band in question. Yet another alternative is to use one synthesiser S1, the phase-locked loop 15 whereof includes two different frequency dividers, one of which is always eligible for use. The division number of the divider 22 is chosen by the control NX. The division number for the PCN system is 2 and for the GSM system 1.

From the mixer 4, the signal first passes through a first intermediate frequency filter 5 to a second mixer 6, where it is mixed with the second mixer frequency LO2 in order to create a second intermediate frequency IF2. From the second mixer 6, the signal passes through a second intermediate frequency filter 8 and through +45° and -45° phase transfer blocks 10 and 11 to a demodulator 12, advantageously to an I/Q demodulator, where the local oscillator frequency LO3 also is brought.

In respective fashion, in the transmitter the signal I-TX, Q-TX entering a modulator in order to be transmitted is taken from the modulator 21, advantageously an I/Q modulator - where in addition to the signal to be transmitted, there also is brought as the modulator carrier wave signal, the frequency of the second mixer frequency LO2 divided by the divider 22 - into a mixer 20; in said mixer 20, the signal is mixed to transmitting frequency FTX with the first mixer frequency LO1. From the mixer 20, the signal is brought through a transmitter-frequency RF filter 19 to a power amplifier 18, wherefrom the amplified signal is brought via the duplex filter 1 to the antenna ANT.

In the description the GSM and PCN systems are as examples: the operating frequencies used in said systems are as follows:

GSM:	reception:	935,2...959,8 MHz
	transmission:	890...915 MHz
	mixer frequency LO1:	1215,6...1240,2 MHz (RX)
		1222,6...1247,2 MHz (TX)
	mixer frequency LO2:	332,4 MHz
	frequency LO3:	26 MHz

5	PCN:	reception:	1805,2...1879,8 MHz
		transmission:	1710,2...1784,8 MHz
		mixer frequency LO1:	1524,8...1599,4 MHz (RX)
			1544,0...1618,6 MHz (TX)
		mixer frequency LO2:	332,4 MHz
		local oscillator frequency LO3 of the demodulator:	26 MHz

10 A drawback of the prior art solution according to figure 1 is that for its RF interface, there is needed a remarkable number of filters (1, 3, 19, 23, 25, 28) and controllable switches (26, 29, 31) on the signal path, which makes the RF front end complicated and increases production expenses. Moreover, the switches cause attenuation on the signal path in the conducting mode, and "leak", i.e. pass signals also in the open state.

15 The object of the present invention is to create an arrangement whereby the above described drawbacks of the prior art can be avoided.

One of the ideas of the invention is that one and the same filter belonging to the RF front end is used for filtering interference from two different signals, in which case the number of filters can be reduced. By means of the solution according to the invention, the number of controllable switches required on the signal path of the RF front end can likewise be minimised. Moreover, it is possible to use only one low-noise amplifier for both reception frequency bands in the receiver part, and only one RF power amplifier for both transmitting frequency bands in the transmitter part.

20 In the prior art it is known to use a synchronised switch in a telephone of a time division system, so that in the receiving mode, the switch directs the signal from the antenna to the receiver and blocks the signal path from the transmitter to the antenna. In the transmitting mode, the switch leads the signal from the transmitter to the antenna and blocks the signal path from the antenna to the receiver. Apart from the filter arrangements, a main idea of the present invention is that one and the same synchronised switch can be used, in addition to time divided transmission and reception selection, also in the selection of the frequency band in multi-mode mobile telephones or in the so-called third-generation systems that apply dual mode operation. Thus the need for additional switches can be avoided.

25 The system according to the invention for transmitting and receiving RF signal, in which transmitting can take place in the first and in the second transmitter frequency band, said first and second transmitter frequency bands being separate, and where the reception can take place at the first and at the second receiver frequency band, said first and second receiver frequency bands being separate, while the arrangement comprises filtering means for filtering the received and transmitted signal, is characterised in that at least one filtering means is used for filtering signals in at least two different frequency bands.

The preferred embodiments of the invention are introduced in the dependent claims.

30 The invention is explained in more detail below, with reference to the appended drawings, where

figure 1 is a block diagram illustrating the RF elements of a prior art mobile telephone operating at two different frequency bands,

40 figure 2 illustrates the frequency bands used in a communication arrangement,

figure 3 illustrates an RF front end according to the invention, suited to be used in the communication arrangement of figure 2,

45 figure 4 illustrates another RF front end according to the invention, suited to be used in the communication arrangement of figure 2,

figure 5 illustrates frequency bands used in another communication arrangement,

50 figure 6 illustrates an RF front end according to the invention, suited to be used in the communication arrangement of figure 5,

figure 7 illustrates another RF front end according to the invention, suited to be used in the communication arrangement of figure 5,

55 figure 8 illustrates frequency bands used in a third communication arrangement,

figure 9 illustrates an RF front end according to the invention, suited to be used in the communication arrangement

of figure 8,

figure 10 illustrates frequency bands used in a fourth communication arrangement, and

figure 11 illustrates an RF front end according to the invention, suited to be used in the communication arrangement of figure 10.

Figure 1 was already explained in the description of the prior art above. In the description below, we shall explain the alternative embodiments of the RF front end according to the invention with reference to figures 2 - 12. The embodiments according to the invention are described only as regards the RF front end; other RF elements of the transceiver can be realised as known in the prior art, for example by using the arrangement illustrated in figure 1.

In the description and claims below, the signal received at the first receiver frequency band or band will be called the first signal, the signal received at the second receiver frequency band will be called the second signal, the signal to be transmitted at the first transmitter frequency band will be called the third signal and the signal to be transmitted at the second transmitter frequency band will be called the fourth signal. Said terms will be used irrespective of the location of said signals in the transmission or reception chain.

Figure 2 illustrates frequency bands used by a communication system on a frequency axis  $f$ , where the frequency is illustrated as growing from left to right. For the first communication procedure, there are reserved separate frequency bands TX for transmission and RX for reception, and for the second communication procedure, there is reserved the frequency band TDD which is used for both transmission and reception. This type of communication system can be for instance UMTS. In the communication arrangement illustrated in figure 2, the distance of the first transmission frequency (TX) from the second transmission frequency band (TDD) and from the second reception frequency band (TDD) is shorter than from the first reception frequency band (RX).

In a transceiver used in the communication arrangement illustrated in figure 2, the transmitter needs RF signal filtering for eliminating false signals, particularly harmonics of the transmitter frequency but possibly also other frequencies. In the reception, filtering is needed for preventing signals external to the band from saturating the receiver. In that case filtering attenuation is particularly needed at image frequency.

Figure 3 illustrates an RF front end according to the invention, suited for the communication system of figure 2. There the RF signal received by the antenna 38 is directed to the switch 32. The switch 32 is controlled so that when receiving at the RX frequency band, the signal is directed to the band pass filter 33, the pass band whereof is set at band RX. After the filter, the signal is amplified in the amplifier 35, from the output whereof there is obtained the signal  $S_{RX}$  obtained from the RX band.

While receiving a signal at the TDD band, the received RF signal is directed, by the switch 32, to a band pass filter 34, the pass band whereof is set at the TDD band. Thereafter the filtered signal is amplified in an amplifier 35, from the output whereof there is received the signal  $S_{TDDRX}$  for further processing.

In the transmitter mode, the signal  $S_{TX}$  and  $S_{TDDTX}$  to be transmitted are amplified in an amplifier 37 and filtered in a band pass filter 36. The pass band of the filter 36 is designed so that both the TX band and the TDD band are located at the pass band of the filter 36. The amplified and filtered signal is then directed to the switch 32, which in the transmitter mode is set to a state where the signal to be transmitted is switched to the antenna 38.

Consequently, in the solution according to figure 3, there is used in the transmission one filter 36, the pass band whereof covers both transmission bands TX and TDD. This is possible when the distance between said transmission bands is short. Yet another prerequisite is that the transmitter has a low noise level and that interference signals are located outside said bands. In addition to the small number of filters, another advantage of the invention is that a switch is not needed in between the transmitter and the filter.

In addition, in the reception the switch there can be eliminated between the filters 33 and 34 and the amplifier 35, if the filter outputs are connected in parallel. In order to prevent both of the filters in parallel connection from attenuating the pass band signals of the other filter, the impedances of both filters must be high at the pass band of the other filter. Thus the transfer of the signal power to the other filter is avoided. If the pass bands of the filters overlap, the parallel connection of the outputs increases the attenuation, because a typical impedance at the pass band is 50 ohm, and in that case part of the signal power is transferred to another filter.

Figure 4 illustrates another RF front end arrangement according to the invention, suited to be used in the communication system of figure 2. There the signal received by the antenna 41 is brought to a band pass filter 42 and to a band pass filter 44. The pass band of the filter 42 is set so that the RX band is located at the pass band of the filter. When a signal is received at the RX band, the received signal is thus switched, via the filter 42, to the amplifier 43, from the output whereof there is obtained an amplified, received signal  $S_{RX}$ .

The pass band of the filter 44 is designed so that both the TDD band and the TX band are located at the pass band of the filter 44. While receiving a signal at the TDD band, the signal received by the antenna 41 thus proceeds through the filter 44, and the filtered signal is directed, by a switch 45, further to the amplifier 43. From the amplifier

output, there is obtained a signal  $S_{TDDrx}$  for further processing.

While transmitting a signal at the TX or TDD band, the signal  $S_{TX}$  or  $S_{TDDtx}$  is directed to an amplifier 46, and the amplified signal obtained from the output thereof is directed, by the switch 45, to the band pass filter 44. As was already maintained, the filter 44 passes both the TDD and the TX band. The filtered transmission signal is further switched to the antenna 41.

By means of the solution illustrated in figure 4, there are achieved the same advantages as by means of the solution illustrated in figure 3. Moreover, in the arrangement of figure 4, only two filters are employed, because transmission uses the same TDD band filter as the reception.

Figure 5 illustrates the frequency bands used by a communication system on the frequency axis  $f$ . For the first communication procedure, there are reserved separate frequency bands, the transmitter frequency band TX and the receiver frequency band RX, and for the second communication procedure, there is reserved the frequency band TDD, which is used in both reception and transmission. The employed frequency bands are located on the frequency axis so that the TDD band and the RX band are located near to each other, and the TX band is located further away of said bands. The communication system illustrated in figure 5 can be for instance a UMTS system. While employing the communication arrangement illustrated in figure 5, similar filtering operations are assumed of the transceiver as was explained above, in the description of figure 2.

Figure 6 illustrates an RF front end system according to the invention, suited to be used in a communication arrangement of figure 5. The signal received by the antenna 61 is there directed, by a switch 62, to a band pass filter 63. The pass band of the filter 63 is designed so that both the TDD band and the RX band are located at the pass band of the filter 63. The filtered signal is amplified in an amplifier 64, from the output whereof there are obtained the received, amplified signals  $S_{RX}$  and  $S_{TDDrx}$ .

In the transmitter mode, the signal  $S_{TX}$  or  $S_{TDDtx}$  is amplified in an amplifier 67, whereafter the signal is directed to band pass filters 65 and 66. The pass band of the filter 65 is designed so that the filter passes the TDD band, and consequently while transmitting at the TDD band, the transmitter signal filtered by the filter 65 is directed, by the switch 62, to the antenna 61. As for the pass band of the filter 66, it is designed so that the filter passes the TX band; consequently, while transmitting at the TX band, the transmitter signal filtered by the filter 66 is directed, by the switch 62, to the antenna 61. By applying the solution according to figure 6, there are achieved the same advantages as with the solution according to figure 3.

Figure 7 illustrates another RF front end arrangement according to the invention, suited to be used in a communication system of figure 5. There the signal received by the antenna 71 is switched to a band pass filter 72. The pass band of the filter 72 is designed so that both the TD band and the RX band are located at the pass band of the filter 72. The filtered, received signal is directed, by a switch 73, to an amplifier 74. From the amplifier output, there are obtained the amplified received signals  $S_{RX}$  and  $S_{TDDrx}$ .

In transmission, the RF signal  $S_{RX}$  or  $S_{TDDtx}$  to be transmitted is fed into the amplifier 76, the output whereof is coupled to a band pass filter 75. The pass band of the filter 75 is designed so that the TX band is located at the pass band of the filter 75, and thus while transmitting at the TX band, the transmitter signal is directed, via the filter 75, to the antenna 71. While transmitting at the TDD band, the transmitter signal is directed, via the switch 73, to the filter 72. As was already stated, the TDD band is located at the pass band of the filter 72, and consequently the transmitter signal is switched to the antenna 71 via the filter 72. The solution according to figure 7 has the same advantages and drawbacks as the solution according to figure 4.

Figure 8 illustrates the use of frequency bands in a third communication arrangement. It comprises the receiver band RX and the transmitter band TX, connected to the first system. In the second system both transmission and reception take place at the TDD band. In the arrangement according to figure 8, the distance between the RX and TX bands is shorter than the distance of the TDD band from the RX and TX bands. The first system can be for instance a GSM system, and the second system can be for instance a DECT, PCS or AMPS system.

Figure 9 illustrates an RF front end system according to the invention, suited to be used in a communication arrangement of figure 8. The signal received by the antenna 91 is there directed by a switch 92 to a filter 93. The pass band of the filter 93 is designed so that both the RX band and the TDD band are located at the pass band of the filter 93. Advantageously the filter 93 should have attenuation both at the TX band and in between the RX and TDD bands. One alternative is to realise the reception filtering with two separate, parallelly connected band pass filters, so that the TDD band is located at the pass band of the first filter and the RX band is located at the pass band of the second filter. It is advantageous to use two parallelly connected filters if a high blocking attenuation is required in between the two bands to be passed by. The filtered signal is further directed to an amplifier 94, from the output whereof there is obtained a received, amplified RX band signal  $S_{RX}$  and TDD band signal  $S_{TDDrx}$ .

In transmission, the TX band signal  $S_{TX}$  or the TDD band signal  $S_{TDDtx}$  is fed into an RF power amplifier 96 and the amplified signal is further directed to a band pass filter 95. The pass band of the filter 95 is designed so that both the TX band and the TDD band are located at the pass band of the filter 95. If the transmitter spectrum is clean, the attenuation requirements of the stop band of the filter 95 are easily met. The filtered signal is further directed, by the

switch 92, to the antenna 91.

Figure 10 illustrates the use of frequency bands in a fourth communication arrangement. It comprises a receiver band RX1 and transmitter band TX1 connected to the first system. In the second system reception takes place at the receiver band RX2, and transmission takes place at the transmitter band TX2. In an arrangement according to figure 10, the distance between the RX and TX bands of the same system is shorter than the distance between the RX and TX bands of two different systems. In the communication arrangement illustrated in figure 10, the first and second system can be for example a GSM and a PCN system.

Figure 11 illustrates an RF front end arrangement according to the invention, suited to be used in connection with the communication arrangement of figure 10. The signal received by the antenna 111 is there directed by a switch 112 to filters 113 and 114. The pass band of the filter 113 is designed so that the first receiver band RX1 is at the pass band of the filter 113. Respectively, the pass band of the filter 114 is designed so that the second receiver band RX2 is at the pass band of the filter 114. Thus the received signal passes either the filter 113 or the filter 114, depending on whether the reception takes place at the band RX1 or the band RX2. The filtered signal is further directed to an amplifier 115, from the output whereof there are obtained the RX1 band signal  $S_{RX1}$  and the RX2 band signal  $S_{RX2}$ . By means of two parallelly connected filters, a high stop band attenuation is achieved in between the RX1 and RX2 bands. The parallel coupling of the filters requires a matching of the impedances, as was explained in connection with the description of figure 3.

In transmission, the TX1 band signal  $S_{TX1}$  or the TX2 band signal  $S_{TX2}$  is fed into an RF power amplifier 117. The amplified signal is directed to a band pass filter 116, the pass band whereof is designed so that both the band TX1 and the band TX2 are located at the filter pass band. The filtered transmitter signal is further directed, by the switch 112, to the antenna 111. In order to be able to use the same filter for the filtering of both the TX1 and TX2 bands, it is advantageous that the transmitter has a clean spectrum, in which case a high attenuation of the stop band is not needed.

A drawback with solutions where the transmitter signal of the TX or TDD band proceeds unattenuated to the receiver is that another telephone located nearby can cause saturation of the receiver. The raising of the saturation point usually means an increase in the power consumption of the receiver, but in TDD reception the saturation point can be effectively raised without any significant increase in the power consumption, because the receiver is on only momentarily in between the reception time slots.

In context with the description of the preferred embodiments above, it was explained in which mode the switches located in the RF signal path are, depending on the transceiver operation and employed frequency range. Said switches are controlled for instance by a processor included in the mobile station. In the memory of the mobile station, there is stored a control programme whereby the processor creates control signals for the switches.

When the mobile station operates in a time division system, the control programme takes care that the switch is controlled so that during the time slot reserved for transmission, the transmitter signal is directed from the transmitter to the antenna, and during the time slot reserved for reception, the receiver signal is directed from the antenna to the receiver.

When the control programme detects in the mobile communications network a command for switching frequency range, it creates a control signal for the switch and controls the switch as was explained in the description of the preferred embodiment above. The same control signal path can be used for the selection of both reception, transmission and frequency band selection.

If the system allows the mobile station user to choose the employed frequency range, the processor creates a control command for the switch on the basis of a command given from the user interface, for instance from the keyboard.

Arrangements according to the invention can be used in a mobile station operating with two different mobile communications systems at two different frequency bands, and in a mobile station operating at two different frequency bands. The solutions of the invention for creating the frequencies required in the reception can also be used in a paging device of a paging system operating at two different frequency bands, wherefore the invention is not exclusively limited to mobile telephones.

The specification above describes only a few applications of the method according to the invention. The principle of the invention can naturally be modified within the scope of the claims, for instance as for the details of the practical realisation, or the ranges of application.

Particularly communication systems and connected frequency bands are explained by way of example only, and the application of the invention is by no means limited to the described communication systems nor to the described relative locations of the transmitter or receiver bands.

## Claims

1. An arrangement for transmitting and receiving RF signal, so that the transmission can take place at a first transmitter frequency band (TX, TX1) and at a second transmitter frequency band (TDD, TX2), said first and second transmitter

frequency bands being separate, so that the reception can take place at a first receiver frequency band (RX, RX1) and at a second receiver frequency band (TDD, RX2), said first and second receiver frequency bands being separate, said arrangement comprising filtering means for filtering the signal to be received and transmitted, **characterised** in that at least one filtering means is used for filtering signals located in at least two different frequency bands.

2. An arrangement according to claim 1, **characterised** in that at least two of said signals, located in at least two different frequency bands, are signals to be received.

3. An arrangement according to claim 1, **characterised** in that at least two of said signals, located in at least two different frequency bands, are signals to be transmitted.

4. An arrangement according to claim 1, **characterised** in that at least two of said signals, located in at least two different frequency bands, are signals to be transmitted, and at least one is a signal to be received.

5. An arrangement according to claim 1, **characterised** in that at least two of said signals, located in at least two different frequency bands, are signals to be received, and at least one is a signal to be transmitted.

6. An arrangement according to claim 1, **characterised** in that it comprises a first amplifier means for amplifying a first and a second signal after reception and filtering, and a second amplifier means for amplifying a third and a fourth signal prior to filtering and transmission.

7. An arrangement according to claim 6, **characterised** in that

- it comprises a first switch (32) having at least two modes and being coupled to an antenna circuit (38),
- said first switch (32) is arranged, in the first mode, to couple the antenna circuit (38) to the first connection of the first, third and fourth filter means (33, 36) in order to direct the first signal from the antenna circuit (38) to the first filter means (33) and in order to direct the third and fourth signal from the third and fourth filter means (36) to the antenna circuit (38),
- the second connection of the first and second filter means (33, 34) is coupled to the input of the first amplifier (35) in order to direct the first signal from the first filter means (33) to the first amplifier (35) and in order to direct the second signal from the second filter means (34) to the first amplifier (35),
- said first switch means (32) is in the second mode arranged to couple the antenna circuit (38) to the first connection of the second filter (34) in order to direct the second signal from the antenna circuit (38) to the second filter (34),
- the second connection of said third and fourth filter means (36) is coupled to the output of the second amplifier (37) in order to direct the third and fourth signal from the second amplifier (37) to the third and fourth filter means (36) and that
- said third filter means and fourth filter means are essentially one and the same filter means (36).

8. An arrangement according to claim 6, **characterised** in that

- the antenna circuit (41) is coupled to the first connection of the first, second, third and fourth filter means (42, 44) in order to direct the first signal from the antenna circuit (41) to the first filter means (42), in order to direct the second signal from the antenna circuit (41) to the second filter means (44), in order to direct the third signal from the third filter means (44) to the antenna circuit (41) and in order to direct the fourth signal from the fourth filter means (44) to the antenna circuit (41),
- the arrangement comprises a second switch (45) having at least two modes, one connection of said switch being coupled to the first connection of the second, third and fourth filter means (44),
- said second switch (45) is in the first mode arranged to couple the second connection of the second filter means (44) to the input of the first amplifier (43) in order to direct the second signal from the second filter means (44) to the first amplifier (43),
- said second switch (45) is in the second mode arranged to couple the second connection of the third and fourth filter means (44) to the output of the amplifier means (46) in order to direct the third and fourth signal from the second amplifier means (46) to the third and fourth filter means (44) and that
- said second, third and fourth filter means are essentially one and the same filter means (44).

9. An arrangement according to claim 6, **characterised** in that

- it comprises a third switch (62) connected to an antenna circuit (61) and having at least two modes,
- said third switch (62) is in the first mode arranged to couple the antenna circuit (61) to the first connection of the first, second and third filter (63, 66) in order to couple the first and second signal from the antenna circuit (61) to the first and second filter (63) and in order to couple the third signal from the third filter means (66) to the antenna circuit,
- the second connection of the first and second filter means (63) is coupled to the input of the first amplifier (64) in order to direct the first and second signal from the first and second filter means (63) to the first amplifier (64),
- the second connection of the third filter means (66) is coupled to the output of the second amplifier means (67) in order to direct the third signal from the third amplifier means (67) to the third filter (66),
- said third switch (62) is in the second mode arranged to couple the first connection of the fourth filter means (65) to the antenna circuit (61) in order to direct the fourth signal from the fourth filter means (65) to the antenna circuit (61),
- the second connection of the fourth filter means (65) is coupled to the output of the second amplifier means (67) in order to direct the fourth signal from the second amplifier means (67) to the fourth filter means (65), and that
- said first and second filter means are essentially one and the same filter means (63).

10. An arrangement according to claim 6, **characterised** in that

- the first connection of said first, second, third and fourth filter means (72, 75) is coupled to an antenna circuit (71),
- the second connection of the third filter (75) is coupled to the output of the second amplifier (76) in order to filter the third signal and feed it to the antenna circuit (71),
- the arrangement comprises a fourth switch (73), coupled to the second connection of the first, second and fourth filter means and having at least two modes,
- said fourth switch is in the first mode arranged to couple the second connection of the first and second filter means to the first amplifier means (74) in order to direct the first and second signal from the first and second filter (72) to the first amplifier means (74),
- said fourth switch (73) is in the second mode arranged to couple the output of the second amplifier (76) to the second connection of the fourth filter (72) in order to direct the fourth signal to the antenna circuit (71) via the fourth amplifier (72), and that
- said first, second and fourth filter means are essentially, one and the same filter means (75).

11. An arrangement according to claim 6, **characterised** in that

- it comprises a seventh switch (92), having at least two modes and being coupled to an antenna circuit (91),
- in the first mode said seventh switch (92) is arranged to couple the antenna circuit (91) to the first connection of the first and second filter means (93) in order to direct the first and second signals from the antenna circuit (91) to the first and second filter means (93),
- the second connection of the first and second filter means (93) is coupled to the input of the first amplifier means (94) in order to direct the first and second signal from the first and second filter means (93) to the first amplifier means (94),
- in the second mode said seventh switch (92) is arranged to switch the first connection of the third and fourth filter means (95) to the antenna circuit (101) and in order to direct the third and fourth signal from the third and fourth filter means (95) to the antenna circuit (91),
- the second connections of the third and fourth filter means (95) are coupled to the output (96) of the second amplifier in order to direct the third and fourth signal from the second amplifier (96) to the third and fourth filter means (95),
- the first and second filter means are essentially one and the same filter means (93), and that
- the third and fourth filter means are essentially one and the same filter means (95).

12. An arrangement according to claim 6, **characterised** in that

- it comprises an eighth switch (112), having at least two modes and being coupled to an antenna circuit (111),
- in the first mode said eighth switch (112) is arranged to couple the antenna circuit (111) to the first connection of the first and second filter means (113, 114) in order to direct the first signal from the antenna circuit (111) to the first filter means (113) and in order to direct the second signal from the antenna circuit (111) to the second filter means (114),



- the second connection of the first and second filter means (113, 114) is coupled to the input of the first amplifier (115) in order to direct the first signal from the first filter means (113) to the first amplifier (115) and in order to direct the second signal from the second filter means (114) to the first amplifier (115),
- in the second mode said eighth switch (112) is arranged to switch the antenna circuit (111) to the first connection of the third and fourth filter means (116) in order to direct the third and fourth signal from the third and fourth filter means (116) to the antenna circuit (111),
- the output of the second amplifier (117) is coupled to the second connection of the third and fourth filter means (116) in order to direct the third and fourth signal from the second amplifier (117) to the third and fourth filter means (116) and that
- said third and fourth filter means are essentially one and the same filter means (116).

13. Use of an arrangement according to claim 7 or 8 in a communication arrangement, wherein

- the second transmitter frequency band (TDD) and the second receiver frequency band (TDD) are at least partly overlapping, and
- the distance of the first transmitter frequency band (TX) from the second transmitter frequency band (TDD) and from the second receiver frequency band (TDD) is shorter than from the first receiver frequency band (RX).

14. Use of an arrangement according to claim 9 or 10 in a communication arrangement, wherein

- the second transmitter frequency band (TDD) and the second receiver frequency band (TDD) are at least partly overlapping, and
- the distance of the first receiver frequency band (RX) from the second transmitter frequency band (TDD) and from the second receiver frequency band (TDD) is shorter than the distance from the first transmitter frequency band (TX).

15. Use of an arrangement according to claim 1 or 12 in a communication arrangement, wherein

- the second transmitter frequency band (TDD) and the second receiver frequency band (TDD) are at least partly overlapping, and
- the distance of the first receiver frequency band (RX) from the first transmitter frequency band (TX) is shorter than the distance from the second receiver frequency band (TDD) and from the second transmitter frequency band (TDD).

16. Use of an arrangement according to claim 12 in a communication arrangement, wherein

- the first transmitter frequency band (TX1), the second transmitter frequency band (TX2), the first receiver frequency band (RX1) and the second receiver frequency band (RX2) are separate from each other, and
- the distance between the first transmitter frequency band (TX1) and the first receiver frequency band (RX1) as well as the distance between the second transmitter frequency band (TX2) and the second receiver frequency band (RX2) are shorter than the distance of the first transmitter frequency band (TX1) and the first receiver frequency band (RX1) from the second transmitter frequency band (TX2) and the second receiver frequency band (RX2).

17. An RF transceiver arranged to transmit RF signals in either of first and second spaced apart transmission frequency bands and to receive RF signals in either of first and second spaced apart reception frequency bands, the transceiver comprising a plurality of band-pass filtering means for filtering received signals and/or signals to be transmitted, at least one of the band-pass filtering means being arranged to pass signals in at least two spaced apart frequency bands.

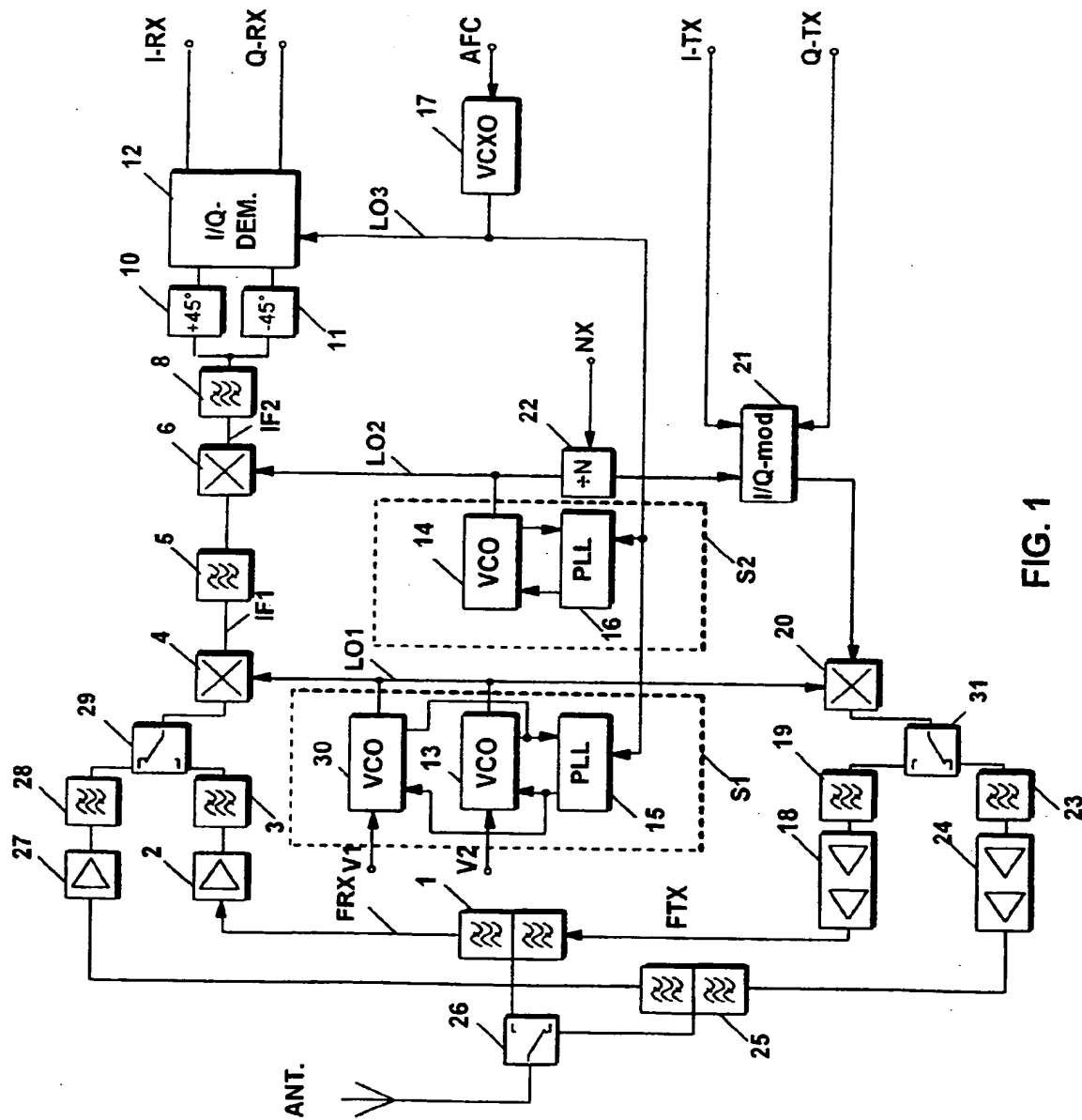


FIG. 1



FIG. 2

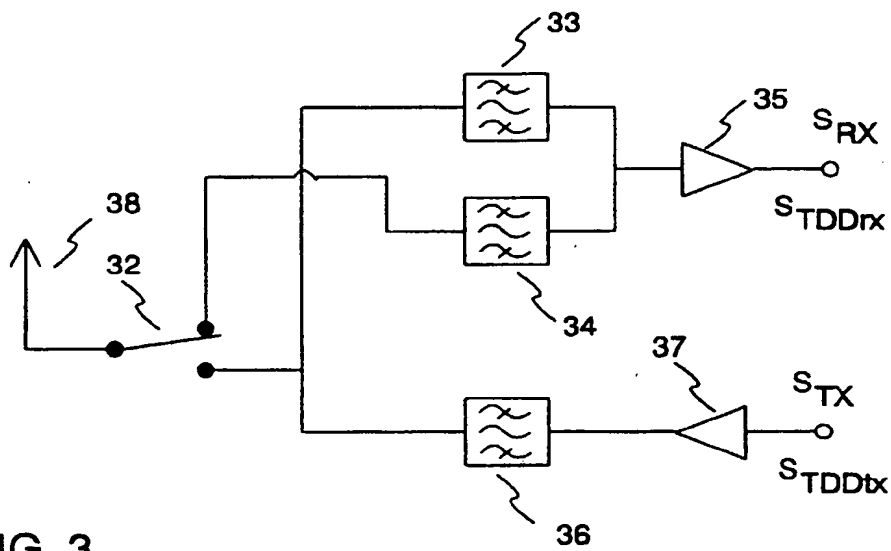


FIG. 3

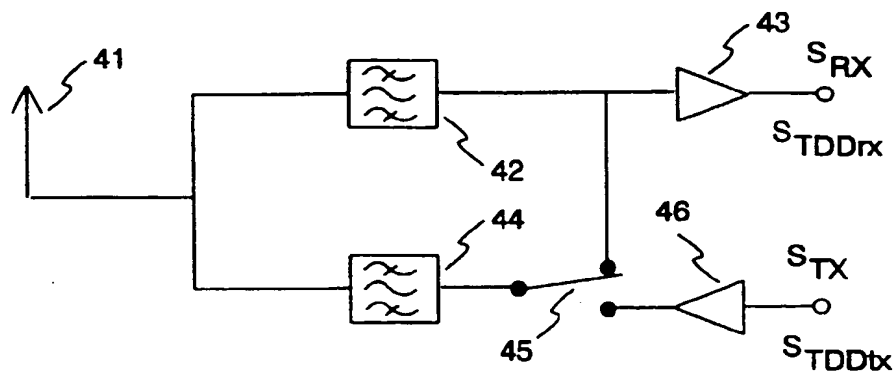


FIG. 4

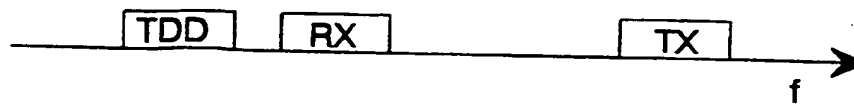


FIG. 5

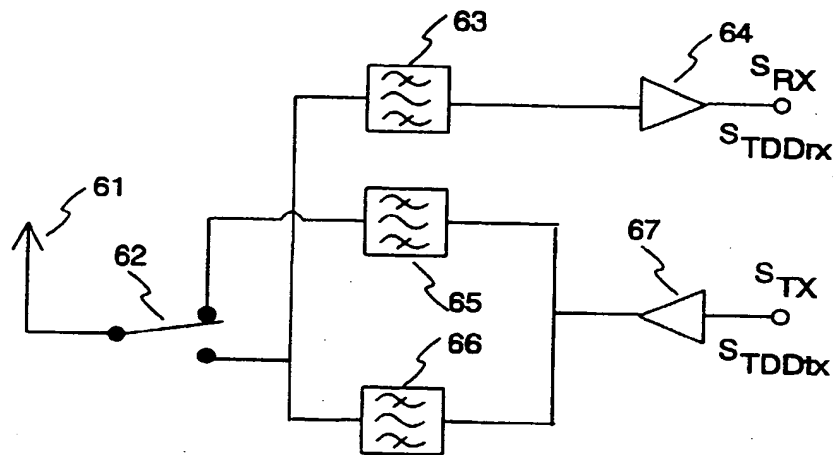


FIG. 6

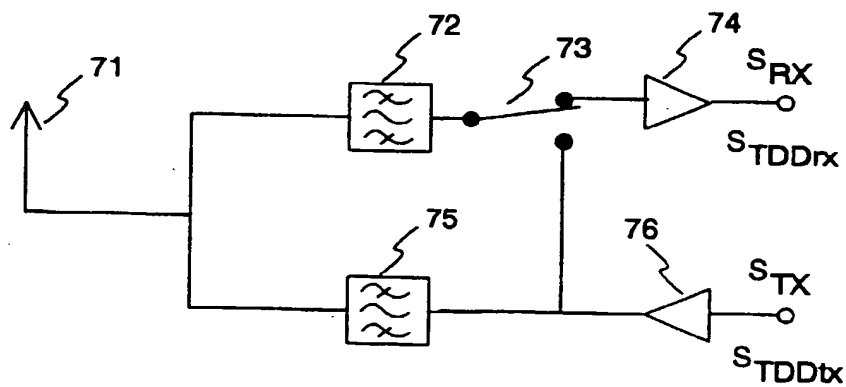


FIG. 7

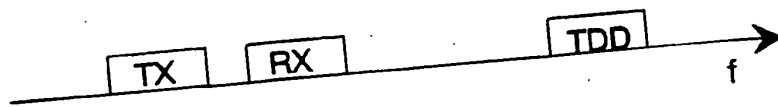


FIG. 8

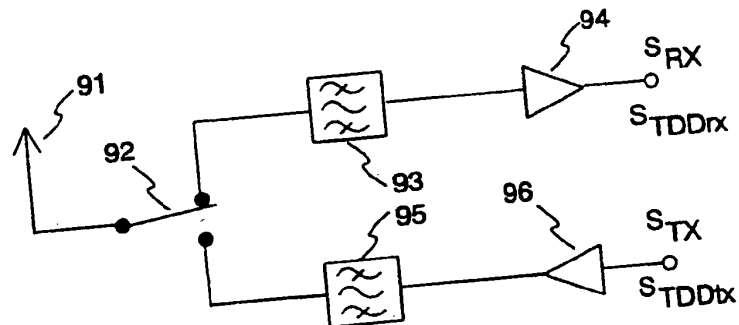


FIG. 9

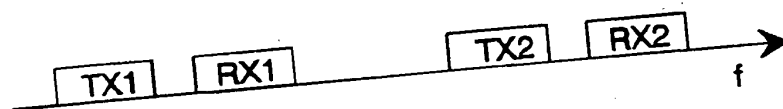


FIG. 10

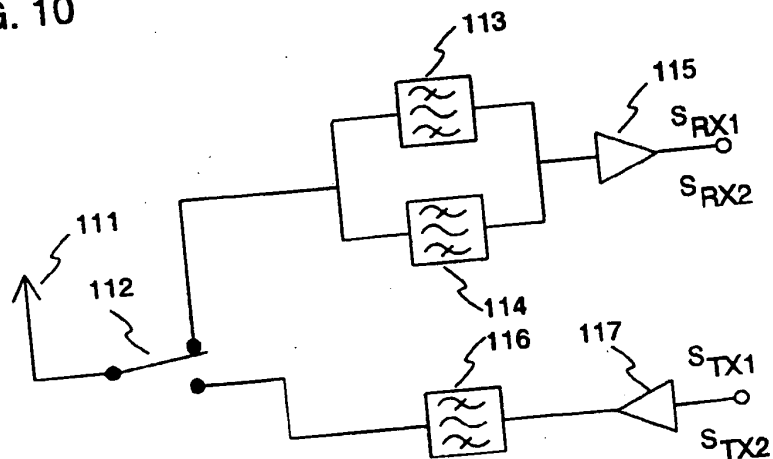
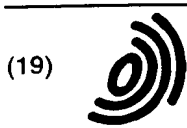


FIG. 11

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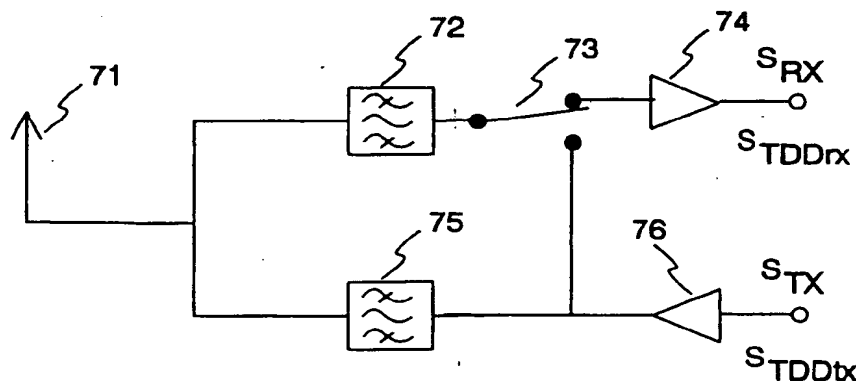
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(54) **Arrangement for transmitting and receiving radio frequency signal at two frequency bands**

(57) The present invention relates to an arrangement for transmitting a radiofrequency signal at two different frequency bands and for receiving at two different frequency bands. The arrangement can be applied for instance to a transceiver of a radio communications system operating at two different frequency bands, or to a transceiver meant to be used in connection with two different radio communications systems. One of the ideas

of the invention is that one and the same filter (72), belonging to the RF front end of the antenna circuit, is used for filtering interference from at least two signals located at different frequency bands, in which case the number of filters (72, 75) can be reduced. By means of the solution suggested in the invention, also the number of controllable switches (73) provided on the signal path of the RF front end can be minimised.



**FIG. 7**



European Patent  
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## EUROPEAN SEARCH REPORT

Application Number  
EP 97 66 0082

DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H04B
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>21 March 2000</b>	Examiner <b>Tzimeas, K</b>
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

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EP 97 66 0082

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